Are Household Production Decisions Cooperative? Evidence on Pastoral Migration and Milk Sales from Northern Kenya

John G. McPeak* and Cheryl R. Doss**

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*Departments of Public Administration and Economics,
215 Eggers Hall,
Syracuse University
Syracuse, NY 13244-1020
Fax: 315-443-9721
Email: jomcpeak@maxwell.syr.edu

**Yale Center for International and Area Studies
34 Hillhouse
P.O. Box 208206
New Haven, CT 06520-8206
203-432-99395

JEL Code: D13, O12

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Abstract:

Development efforts often introduce new opportunities for generating income from traditionally produced goods. Production of these goods within the household may be characterized by a gender division of labor. Development efforts may go awry when providing a new opportunity to market a good produced by one household member that is conditioned upon production decisions made by another household member if decisions are non-cooperative. Among the pastoralist Gabra of Northern Kenya, men decide where to migrate with the household herds while women manage the milk, including the decision of whether to sell milk. Traditional decision making patterns are challenged by the increase in milk marketing opportunities in small towns in northern Kenya. We test three models of household decision-making. The results suggest that household decisions are contested, with husbands using migration decisions to resist wives' ability to market milk.

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Introduction

When new opportunities such as improved market access or new production technologies are introduced into societies, the benefits are often contested. In particular, men and women frequently renegotiate their traditional roles and responsibilities with the advent of new opportunities. Some evidence, much of it descriptive and anecdotal, suggests that it may not be appropriate to model household decisions regarding the use of these new opportunities as cooperative decisions. Cooperative models may overlook the contested nature of intra-household decision making. Understanding the nature of such contestation is critical for those who seek to introduce new opportunities to a given society in the name of development. What appears to be a beneficial intervention under the assumption that households act cooperatively may instead have little impact or even lead to unforeseen adverse outcomes if decisions are contested.

In most economic analyses, we take market institutions as a fixed set of rules that guide economic behavior. It is, however, important to recognize that development efforts often focus on bringing goods that have been traditionally produced and consumed within the household into the market domain. As market institutions develop, new rules associated with the market must be reconciled with existing cultural institutions. Observed economic behavior may be the result of a negotiation process over which rules, those of the market or those prevailing in the culture, are applicable.

In this study, we investigate intra-household patterns of decision making for the Gabra who are nomadic pastoralists, living in an arid climate in northern Kenya. Over the past thirty years, herders in northern Kenya have seen a rapid growth of milk marketing opportunities. What makes this situation intriguing is that among the Gabra, traditional cultural rules allocate the responsibility to decide where to locate the household to the husband, while the management of milk is the wife's domain. As livestock-raising in the Gabra area requires frequent migration and milk marketing only takes place in the small market towns of the study area, the analysis of these two decisions allows unique insight into intra-household negotiation over new market opportunities. Simply put, we investigate how men use their decision-making power on migration to influence women's milk marketing activities.

We describe in this study four possible reactions by households to the new opportunities presented by the development of milk markets. The first possibility is that a husband and a wife recognize economic benefits provided by the new market opportunity and make joint decisions on location and milk marketing to maximize household welfare. We call this the joint cooperative solution. A second possibility is that in response to the new opportunity, the husband takes over milk marketing and decides individually regarding location and milk marketing. This we call the individual solution.[1] A third possibility is that a husband continues to make location decisions without considering the impact on milk marketing. We call this the traditional solution. The final possibility is that a husband views his wife's use of milk markets with trepidation, as milk marketing allows a wife to expand her traditional control over household milk to the new opportunity to control cash income. In this case, a husband may make a location decision to limit his wife's ability to market milk. We call this the contested solution. We formally model these outcomes below and then empirically investigate the pattern of household decision-making using panel data from Gabra pastoral households.

The outline of this study is as follows. Section two presents a brief review of the literature on intra-household decision-making and the literature on intra-household issues of milk marketing in pastoral areas. Section three describes the nature of pastoral production in the study area. Section four presents information on the data used in this study. Section five formalizes the three models of decision-making described above: the cooperative model, the traditional model, and the contested model. In section six, results of empirical analysis of household decisions are presented. A concluding section discusses the implications of these findings.

Empirical Literature on Cooperative and Noncooperative Outcomes

Much of the literature on household decision-making assumes that households act cooperatively and examines which cooperative model, a unitary model or a bargaining model best fits the data.[2] The literature on intra-household consumption decisions is extensive. Studies that explicitly test for whether the assumptions of the cooperative model hold in consumption decisions tend to reach findings that reject the unitary model but do not reject Pareto efficiency as a characteristic of household decision making (Thomas *et al.,* 2002; Thomas and Chen, 1993). Many studies use this finding to offer models of cooperative household decision making that do not rely on the unitary model (Quisumbing and Maluccio, 2003; Attanasio and Lechene, 2002; Hallman, 200l; Lundberg and Ward Batts, 2000; Doss, 1999; Lundberg *et al.*, 1997).

A separate theme in the literature is intra-household household decision making with regard to supplying labor. Two studies extend Chiappori's (1988) collective model of labor supply to examine censoring and nonparticipation in employment (Blundell *et* *al.*, 2002) and marriage markets and divorce (Chiappori *et al.*, 2002). Again, studies on this theme tend to support the assumption that household decision making is cooperative.

Less support for the assumption of cooperative decision making is found by studies examining risk sharing within households. Two studies suggest that household members do not make decisions that fully pool their risk with each other. Dercon and Krishnan (2000) find that poor households in southern Ethiopia do not engage in complete risk sharing; women in these households bear the brunt of adverse shocks. They reject the collective model of the household which imposes Pareto efficiency on allocations. Doss (2001) finds that in Ghana shocks to men's and women's incomes have different affects on household expenditure patterns. These studies provide support for the idea that household members may be concerned about their individual long-term access to resources and that membership in a household is one way, but not the only way, that they seek to ensure this access.

Another theme in the literature that tends to find less support for the cooperative decision making model, and the one of greatest relevance to the current study, is investigation of intra-household production decisions. Udry (1996) uses detailed agronomic data from Burkina Faso and finds that crop yields are different on plots controlled by men from those controlled by women within the same household in a given year. He also finds that households could achieve higher total output by reallocating labor and fertilizer from men's plots to women's plots. Pareto efficiency would require that marginal productivity for an additional unit of labor or fertilizer be the same across all plots owned by the household. Thus, he rejects a cooperative outcome. Similarly, Jones (1983) rejects the hypothesis of a cooperative outcome in her study of labor allocation following the introduction of irrigated rice production in Northern Cameroon. Both men and women continued to grow sorghum after irrigated rice was introduced, even though the returns to labor from rice production were higher. Men and women jointly cultivated the rice fields, whereas sorghum plots were individually cultivated. Reallocating labor from sorghum to rice would again have increased total household production. Women received some compensation for working on rice plots, but the amount of compensation was contested and thus, the labor was not reallocated.

This example from Cameroon highlights a theme that is found frequently in the literature on women in development – the introduction of new production opportunities interacts with an existing gendered division of labor to lead to unforeseen outcomes. Von Braun and Webb (1989) present findings similar to Jones, as they find the introduction of irrigated rice in The Gambia led to men taking over rice cultivation, displacing the women who had traditionally grown rice. Women, in turn, began growing cotton and groundnuts, which were traditionally men's crops. Lapido (1991) describes how the introduction of a mechanical maize sheller into a Nigerian village shifted the control of the shelling process from men to women. The men responded by contesting the women's right to charge for shelling and eventually some of the men seized the machine. In a variety of settings, then, it has been found that the introduction of new production opportunities can have unpredictable outcomes when there is a culturally defined gender division of labor.

The literature on milk marketing in pastoral areas also reflects this theme. It has been frequently observed in pastoral areas of Africa that the management of milk, including milk marketing, is controlled by women (Coppock 1994, Holden 1991, Bekure et al. 1991, Sikana and Kerven, 1991; Herren 1991, Ensminger 1987, Waters-Bayer 1985). These studies also note that the development of milk marketing is a relatively new phenomenon that has occurred in pastoral areas over the past 30 years.

The impact of this development on household decision making varies by the study site. Michael (1987) presents findings from the Sudan that are consistent with a cooperative outcome. She reports that men recognize the growing importance of milk marketing and adjust their migration decisions to incorporate this new opportunity. Ndagala (1982) presents findings from Tanzania that are consistent with the individual solution. In this case, men took over control of milk marketing and the cash it generated when a market opportunity was introduced. Evidence consistent with the contested model is provided by Waters-Bayer (1985) in her Nigerian site. Here it was found that the fact that women control income from milk production yet men are responsible for purchasing herd inputs limits the potential for milk production improving technologies to be adopted. Another study providing indirect evidence consistent with the contested model is Nduma *et al.* (2001) who report that pastoral women in northern Kenya are less likely to market milk when a husband is present in the household, all else held equal.[3]

Given this wide range of outcomes, we seek in this study to formalize the nature of the different types of outcomes. We also shed light on this topic by investigating empirically the nature of household decision making in northern Kenya. We contribute to the literature on this topic both by presenting evidence relevant to the study area from which the data was drawn and by developing a simple but intuitive methodology to investigate intra-household patterns of decision making.

Gabra Pastoral Production

Gabra are nomadic pastoralists living in northern Kenya and southern Ethiopia. Gabra inhabit an extremely arid and variable environment in which cultivation is not possible. Mean annual rainfall is below 300mm for most of the Gabra rangelands. Rainfall is also highly variable, with a coefficient of annual variation of 0.55 at the center of the Gabra rangelands in North Horr. Gabra households share access to their grazing area, and migrate throughout this area with their herds of camels, cattle, goats and sheep, in reaction to changing pasture conditions. They rely almost exclusively on their herds to meet their subsistence and income needs. Almost all income is from livestock and milk produced by the household herd is the major component of household consumption. Assigning market values to home consumed goods reveals that on average: 72% of household income is accounted for by milk produced by the household herd[4]; 14% is obtained by the sale of animals; 13% is obtained by home consumption of slaughtered animals, and 1% is obtained by skin and hide sales, gifts, and remittances.[5]

In Gabra culture, the husband has the right to decide when and where to move the household and the household herd. Such moves can be over extremely long distances. Traditionally, upon the husband's decision to migrate, the housing materials and all the household belongings are loaded onto camels and moved to the new location he has selected. It is the woman's responsibility to reconstruct the house when they reach the new location and the husband's responsibility to build new night enclosures for the animals from thorny bushes. They remain at this site until the husband decides the time has come to move again. The husband also makes decisions about splitting the herd.

Gabra households with some frequency establish a satellite camp that moves male and non-lactating animals away from the milk herd that is kept at the base camp.

All things inside the hut are under control of the wife. Gabra symbolism is rich with contrasts between that which is inside the hut (female) with what is outside the hut (male). This is played out each evening in the ritual surrounding the milking of the herd. After the animals return from grazing, they are placed in their night enclosures and milked by a designated milker (women are not allowed to milk camels, nor are sexually active men). The containers full of milk are then taken to where the husband sits outside the door of the hut. He inspects the milk, takes a ritual sip, and then passes it through the door into the hut where his wife receives it. When it passes into the hut, it becomes the wife's and it is her responsibility to manage it.

Traditionally, the management responsibility meant that the wife decided how much to use for each meal, how much to conserve as fermented milk or ghee, and how much to give away to other households. Increasingly, it means she decides how much of the milk will be marketed and how much will be consumed by the household. The marketing option has introduced a change in the nature of the management decision. Marketing allows the transformation of milk produced from the herd into cash. As she will usually spend this money on goods before returning to the family in the evening, she is now presented with a new set of decision-making opportunities regarding how to spend this income. We use evidence on how men use migration decisions to influence their wife's milk sales to investigate the nature of the intra-household negotiation over granting the wife this decision-making power.

Description of the Data

This study uses longitudinal data gathered in two areas of Marsabit District, Kenya. Gabra pastoralists occupy the two areas studied: the Chalbi area and the Dukana area. The Chalbi area is drier than the Dukana area, but has more water points as it lies along the lowland Chalbi basin. Dukana is more remote and less served by transport; vehicles traveling to Dukana must first past through Chalbi. Markets are more active in Chalbi than in Dukana partially due to this difference in transport availability.

The sampling methodology used in this study is similar to a transect as no list of pastoral households existed for this area. Enumerators moved between the main towns of the study area (Kalacha and North Horr in Chalbi and Sabarei and Dukana in the Dukana area) interviewing herders they encountered at nomadic camps along the way.[6] The questionnaire was retrospective in nature, recording information for four time periods per year for each of the years 1993-1997.[7] Within a year, the four time periods correspond to the bimodal rainfall pattern of the area: the long rains, the dry season following these rains, the short rains, and the dry season following these rains. Each period is roughly three months in length. This approach provided multiple data points for a given household (from 16 to 20 data points, depending on when the household was interviewed in 1997 or early 1998).[8]

Respondents were asked to report the following variables for each time period: ages of household members; household size; starting period household herd size and species composition; land-use decisions; average milk production from the herd per day[9] and total milk sales per period; and other sources of household income. Household size was converted into an adult equivalent scale following the method outlined by Martin

(1985).[10] Variables recording herd size are converted to total livestock units (TLU), following the method of Schwartz *et al*. (1991).[11] The median Chalbi household had six residents (4.5 adult equivalents) while the median Dukana household had five residents (4.3 adult equivalents). The median herd size per species in Chalbi was: 9 camels, 2 cattle, and 193 sheep and goats. In Dukana the corresponding figures are: 4 camels, 5 cattle, and 58 sheep and goats.

Households also reported for each time period, the location of the base camp, as measured in the number of hours it took to walk from the settlement to the nearest market town, and the number of people and animals sent to a satellite camp if one was established. The distance between the base camp and town averaged just over five hours' walk in the Chalbi and in Dukana the average was over eight hours. In both areas, roughly half of the households reported changing the distance they settled from town from one three month period to the next. Households also reported they established a satellite camp in addition to the base camp for 47% of Chalbi observations and 44% of Dukana observations.

Median milk production per day in the Chalbi area was 4.5 liters per household per day, 34% of which came from camels, 5% from cattle, and 61% from sheep and goats. In Dukana the corresponding figure are 3.5 liters per household per day, 21% from camels, 26% from cattle, and 53% from sheep and goats. In the Chalbi sample, 67% of surveyed households sold milk at some time between 1993 and 1997. In Dukana, 86% of surveyed households were involved in milk marketing over the same period. Milk sales accounted for 11% of household cash income on average in Chalbi and 14% in Dukana.

The data set also records variables exogenous to the household. Monthly rainfall data was gathered at the North Horr Catholic mission and the Kalacha African Inland Church mission. The rainfall variable is constructed as the average of these two sites for a given season. Three variables are used to record rainfall characteristics of a given time period; one measures total rainfall in the current three-month period plus the last three-month period as this corresponds to the effective growing season for pasture in this bi-modal rainfall system, and two dummy variables record whether the period in question is a rainy season. A variable records the tons of food aid delivered to the towns of the study area in a given time period and is constructed from data gathered at the above mentioned missions which are also food aid distribution points.[12] Table 1 presents summary statistics of variables used in later regressions.

Models of Household Decision Making

We develop three static models of intra-household decision making in this section that correspond to different decision making scenarios.[13] In each model, the household members are confronted with a decision about how much milk to sell and where to locate the household. We consider the implications of each scenario in turn.

A) Cooperative Decision Making

In this model, the household decides on the distance to settle from town and the milk sales level in a cooperative manner. Here, we model it as a joint decision by the husband and wife. For our purposes, the results derived from this model and the individual model, where the husband takes over the milk marketing and makes both sales and distance decisions himself, are the same.[14] The outcome maximizes the joint household separable utility function. For both the husband and wife, define a logarithmic utility function. Utility is an increasing and concave function of consumption. Total household utility is obtained by summing the utility of the husband and the wife. Therefore total household utility is defined by

$$U(c) = \ln(c^h) + \ln(c^w) \qquad (1)$$

where *h* represents the husband, *w* represents the wife. Consumption (*c*) includes milk consumed by the household members, goods purchased with the income from milk sold, and goods purchased from the sale of livestock. Assume that decisions over the sale of livestock occur prior to decisions over household location and milk sales, so that the herd contribution to consumption is fixed at *hc* when the location and milk sales decisions are made.[15] Total milk production is *m*, milk sales occur at price *p*,[16] and milk sales are represented by *s*. Consumption can be represented

$$c = hc + (m - s) + s \cdot p \qquad (2)$$

The distance from town to the household location is represented by *d*. Milk markets are located in towns. Therefore, the labor effort involved with marketing milk is an increasing function of milk sales and distance from town. Assume the labor cost of milk marketing can be represented by a multiplicative specification $\omega_1 \cdot s \cdot d$, where ω_1 represents a parametric weight on milk marketing labor.

Towns also are the centers of amenities, such as health centers, schools, news and communication centers, public security, and markets for consumption goods. Therefore, settling further from town provides disutility by reducing household members' ability to access these amenities. However, as other herders also desire to be near town to take advantage of these amenities, the necessary labor effort for herding increases the closer one settles to town. Represent these two countervailing influences by

$$-\omega_2 \cdot d - \omega_3 \cdot \left(\frac{1}{d}\right) \tag{3}$$

where ω_2 and ω_3 again represent a parametric weight on distance.

The household thus solves the following problem.

$$\underset{s,d}{Max} \quad \ln(hc + (m-s) + s \cdot p)^h + \ln(hc + (m-s) + s \cdot p)^w - \omega_1 sd - \omega_2 d - \omega_3 \cdot \left(\frac{1}{d}\right) \tag{4}$$

The solution of this problem provides the following conditions:

$$\mathrm{d} = \left(\frac{\omega_3}{\omega_2 + \omega_1 \cdot \mathrm{s}}\right)^{\frac{1}{2}} \tag{5}$$

$$\mathrm{s} = \left(\frac{2}{\omega_1 \cdot \mathrm{d}}\right) - \left(\frac{\mathrm{m}}{\mathrm{p}-1}\right) - \left(\frac{\mathrm{hc}}{\mathrm{p}-1}\right) \tag{6}$$

Thus, in the cooperative model, the two decisions are made simultaneously and each depends on the other. Households choose the distance from town as a decreasing function of milk sales. Households choose milk sales as a decreasing function of distance.

B) The Traditional Model.

In this model, we assume that the husband makes the location decision without considering how this influences milk sales. In this case, a husband acts and the wife reacts. The husband is still operating under the traditional cultural rules, and has not yet introduced milk marketing as a strategic consideration in his decision. Although we did not find any evidence supporting this model in the literature, it was an explanation proposed to us by Gabra respondents during our fieldwork, so we include it in this section. Assume he views the proceeds of milk marketing as his wife's concern and does not consume the products purchased from milk sales. He decides where to locate the herd based on his own considerations and leaves it to his wife to adjust her milk marketing accordingly. The husband decides the distance from town variable by solving the problem

$$\underset{d}{Max} \quad \ln \ (hc + (m - s))^{h} - \omega_2 \cdot d - \omega_3 \cdot \left(\frac{1}{d}\right) \tag{7}$$

while his wife takes the distance as given and solves:

$$\underset{s}{Max} \quad \ln \ (hc + (m - s) + s \cdot p)^{w} - \omega_1 \cdot s \cdot d - \omega_2 d \tag{8}$$

The solutions to this problem are

$$\mathrm{d} = \left(\frac{\omega_3}{\omega_2}\right)^{\frac{1}{2}} \tag{9}$$

and

$$\mathrm{s} = \left(\frac{1}{\omega_1 \cdot \mathrm{d}}\right) - \left(\frac{\mathrm{m}}{\mathrm{p} - 1}\right) - \left(\frac{\mathrm{hc}}{\mathrm{p} - 1}\right) \tag{10}$$

In this case, distance is determined independently of milk sales and the milk sales decision is a decreasing function of distance.

C) The Contested Model.

In this model, as in model (B) we assume that women control the income from milk sales and that the proceeds from milk sales do not enter the husband's consumption. In contrast to model (B), the husband now understands that the introduction of milk marketing has created a new decision-making context. In this situation, the husband realizes that his power as first mover allows him some leverage to manipulate his wife's milk sales. [17] As the milk sales lead to less milk in his consumption and more income in his wife's control, it is in his interest to reduce the wife's incentive to sell.[18]

Men thus again solve the following problem:

$$\underset{d}{Max} \quad \ln \ (hc + (m - s))^{h} - \omega_2 \cdot d - \omega_3 \cdot \left(\frac{1}{d}\right) \tag{11}$$

while the wife is faced with the problem

$$\underset{s}{Max} \quad \ln \ (hc + (m - s) + s \cdot p)^{w} - \omega_1 \cdot s \cdot d - \omega_2 \, d \tag{12}$$

Solving recursively, we arrive at the first order condition for the wife from (12) above. Substituting this into the husband's decision problem and maximizing gives us the following.

$$\underset{d}{\mathrm{Max}} \quad ln^{h}(\mathrm{hc} + \mathrm{m} - \left(\frac{1}{\omega_1 \cdot \mathrm{d}}\right) + \left(\frac{\mathrm{m}}{\mathrm{p}-1}\right) + \left(\frac{\mathrm{hc}}{\mathrm{p}-1}\right)) - \omega_2 \cdot \mathrm{d} - \omega_3 \cdot \left(\frac{1}{\mathrm{d}}\right) \tag{13}$$

Solving this problem gives us the following condition.

$$\mathrm{d} = \left(\omega_3 + \left(\omega_1 \cdot \omega_2 \cdot (\mathrm{hc} + \mathrm{m} - \mathrm{s}^{*}\right)^{-1}\right)^{\frac{1}{2}} \tag{14}$$

where, as in (2b),

$$\mathrm{s}^{*} = \left(\frac{1}{\omega_1 \cdot \mathrm{d}}\right) - \left(\frac{\mathrm{m}}{\mathrm{p}-1}\right) - \left(\frac{\mathrm{hc}}{\mathrm{p}-1}\right) \tag{15}$$

In this case, distance is an increasing function of milk sales, and the milk sales decision is a decreasing function of distance.

The comparison of the three models is summarized as follows:

	Cooperative	Traditional	Contested
Distance Variable	Decreasing in s	Not a function of s	Increasing in s
Milk Sales Variable	Decreasing in d	Decreasing in d	Decreasing in d

We expect the milk sales variable to be always decreasing in distance. The distinction between the three models depends on the sign and the significance of the milk sales parameter in the equation for distance. These results provide the foundation for the empirical estimations that follow.

Empirical Analysis

In this section, we use observed values for the distance a household settles from town in a given period and the total amount of milk sold in the period to investigate the relationship between these decisions. We estimate these two decision variables jointly. Denoting the distance from town decision by *d*, the milk sales decision by *s*, γ and β as parameters to be estimated, *X* as matrices of exogenous variables, and *u* as underlying disturbance terms, the following two equation system is defined:

$$\begin{aligned} d &= \gamma_s \cdot s + \beta_d X_d + u_d \\ s &= \gamma_d \cdot d + \beta_s X_s + u_s \\ u_d, u_s &\sim BVN(\sigma_d^2, \sigma_s^2, \rho) \end{aligned} \tag{16}$$

Given our analysis above, the parameter of interest is the sign and significance of γ_s in the distance equation. If estimation reveals it to be negative and significant, this result is consistent with the cooperative model. If it is not significant, the result is consistent with the traditional model. Finally, if we find it to be positive and significant, this provides a result consistent with the contested model.

To identify the system, we need a variable that affects milk sales but not location and one that affects location but not milk sales. One variable that can be used in the distance equation is last period's distance from town. In addition, we are using the age of the oldest female in the household (and age squared) in the milk sales equation and the age of the oldest male in the household (and age squared) in the distance equation. The oldest male and oldest female are most frequently the husband and wife, although there are a few cases where this records a mother and son when the household is female headed. Because location decisions are men's decisions, the characteristics of the man making the decision are the relevant variables to include in estimating this decision. Similarly, since women control the milk marketing decisions, the characteristics of the woman making the decisions are the relevant variables for this decision.[19] As will be seen below, these variables are statistically significant in the estimations.

Three issues emerge when attempting to estimate this system of equations. First, both dependent variables are by construction non-negative and censored at zero. Distance from town equals zero for 7% of observations in Chalbi and 3% in Dukana. In addition, no milk was sold for 72% of observations in Chalbi and 82% in Dukana.[20] Failure to take account of the censored nature of dependent variables results in inconsistent parameter estimates. As the equations are specified as a system, the methodology used is full information maximum likelihood estimation of a bivariate tobit system (Maddala, 1982).

A second issue arises due to the longitudinal nature of the panel data. It is possible that there are underlying household specific characteristics that influence livestock transfer behavior. If not controlled for, the presence of such characteristics will lead parameter estimates to be inconsistent (Hsiao, 1986). The response used to address this issue was to include a time invariant household specific effect by creating a matrix recording the means of household specific variables for all time periods observed and using simulation methods to control for a household specific random effect that is uncorrelated with the observed means (Gourieroux and Monfort,1993).

Finally, as has been noted, there are significant differences between the two study areas in terms of production and market conditions. To allow for parametric differences between the sites, estimations are conducted separately for the Chalbi and the Dukana data. Table 2 presents results of simultaneous tobit estimation of milk sales and distance from town decisions for the Chalbi sample and the Dukana sample.

[insert table 2]

The results show clearly that the coefficient on milk sales in the distance estimation is positive and significant, thereby supporting the contested model of the household. As expected, the coefficient on distance in the milk sales estimation is negative and significant. As distance increases, milk sales decrease.

The herd size variables are not statistically significant in the estimation of either location or milk sales decisions in Chalbi, but are significant for the Dukana results. As herd size per adult equivalent increases, both distance from town and milk sales increase. For the Dukana results there is some evidence of seasonality in both distance from town and milk sales based on the seasonal dummies. During rainy seasons households move closer to town and also sell more milk. In Dukana, food aid deliveries decrease the distance from town and increase milk sales. Food aid is usually delivered to the towns and thus food aid deliveries provide an incentive for people to locate closer to town.

Two alternative explanations to the contested decision making hypothesis could explain the observed pattern of the endogenous coefficients and should be considered. First, it could be the case that the positive coefficient for milk sales in the distance equation reflects cooperative behavior as a move further from town increases milk production, thus increasing the wife’s ability to sell milk. This would be the case if milk production is an increasing function of distance from town. We investigate this possibility by conducting fixed effects estimation of the milk production data presented in table three. We find no significant impact on milk production that can be attributed to the distance a household settles from town.

[insert table 3]

A second alternative interpretation of our results recognizes that the distance a household settles from town and the use of a satellite camp are to some degree substitutes (McPeak, 2003). By moving further from town, a household is able to occupy less crowded pastures and allow for the satellite herd to rejoin the base camp herd. This could also explain the observed results in a way that is cooperative, rather than contested. This is not likely to be the explanation, as satellite animals tend to be composed of male and non-lactating animals in this area while milk herds are kept at the base camp with the family. However, we can not reject this hypothesis directly given data limitations.[21]

Conclusion

The results are consistent with a contested model of household decision-making. Men appear to be making decisions about the distance from town in order to limit women's ability to market milk. This result is consistent with the notion that men resist the ability of their wives to move milk from current cultural institutions into the market domain. While there may be benefits to increased milk marketing in this area, our results suggest men are reluctant to facilitate this increase.

Is this contestation a good thing or a bad thing for overall household welfare? We do not have the data to adequately address this issue in this context. Some studies indicate that income in women's control is more likely than men's income to be spent on goods for children (Hoddinott and Haddad, 1995; Thomas, 1993). This would suggest that children's welfare will increase when women earn income from milk sales. On the other hand, by selling milk, women are also reducing the amount of milk available to the household. As noted on the literature on pastoral sedentarization, there is a clear link between child malnutrition and lack of access to milk (Fratkin *et al.*, 1999). Thus, the impact on children is ambiguous. We leave as a topic for further study who is "right" in this case; husbands who argue milk marketing has a negative impact on household utility or wives who argue it has a positive impact on household utility.

What we can say is that husbands and wives are in a process of adjusting to the new opportunity brought about by milk marketing in this area. Our evidence suggests the most appropriate way to understand the process is one of contestation. Husbands are using their traditional right to decide migration patterns to influence wives sales' decisions. Wives are asserting that their traditional right over milk management extends to this new setting. This finding suggests that the introduction of market opportunities for goods that are traditionally home consumed may meet with resistance within the household. In addition, development efforts that attempt to support milk marketing in such a setting must be designed in awareness that such contestation is occurring.

Table 1. Descriptive Statistics

Variable	Chalbi Mean	Chalbi Standard Deviation	Dukana Mean	Dukana Standard Deviation
Distance --base camp to town (hours walk)	5.13	4.78	8.27	8.22
Value of Milk Sales (liters per period * 20 shillings per liter)[a]	408.47	843.57	29.27	70.05
Milk Production (liters per day)	5.33	4.67	3.71	2.19
Herd size in TLU	43.27	32.70	18.66	6.84
Herd size in TLU / Adult Equivalent	9.07	5.14	4.68	1.77
Household Size in Adult Equivalents	5.09	2.12	4.14	0.99
Percent at satellite camp (of labor force for Chalbi, of herd for Dukana)	33.88	31.89	24.15	30.56
Rainfall in mm over past six months	58.39	42.09	65.53	47.57
Long Rains Dummy	0.27	0.45	0.25	0.43
Short Rains Dummy	0.24	0.43	0.25	0.43
Food aid deliveries in tons per period	72.37	88.97	65.22	85.74
Age of oldest male in household	47.12	14.33	53.12	12.09
Age of oldest female in household	37.19	13.48	36.50	10.04
Number of Observations	707		980	
Number of Households	39		49	

[a] Note that the price of milk was constant at 20 shillings per liter over the entire period.

Table 2. SFIML Simultaneous Tobit Estimation of Distance from Town and Milk Sales.

	Chalbi		Dukana	
	Distance from Town	Milk Sales x 10^{-3}	Distance from town	Milk Sales x 10^{-3}
Milk Sales x 10^{-3}	3.5449 ***		2.6504 ***	
	(0.2591)		(0.9013)	
Distance from town		-1.2168 ***		-0.1166 ***
		(0.2906)		(0.0372)
Constant	-14.2861 ***	-11.2505 **	12.9007 ***	-12.3480 ***
	(4.0100)	(4.0798)	(6.2097)	(3.1335)
Last Period Distance	0.4257 ***		0.5275 ***	
	(0.0474)		(0.352)	
Herd size per Adult Equivalent x 10^{-1}	2.9356	0.2844	4.1105	6.5023
	(2.2283)	(1.6920)	(10.7018)	(4.1477)
Herd size per Adult Equivalent^2 x 10^{-3}	-9.8904	-0.8105	-8.5054	-2.9137
	(7.8182)	(6.3065)	(9.0253)	(3.4966)
Food aid deliveries x 10^{-3}	-1.3528	-1.6547	-1.2477 **	0.8154 ***
	(4.2737)	(2.1837)	(0.5389)	(0.2572)
Rainfall in past six months x 10^{-2}	0.6592	0.2500	0.5257	0.1007
	(0.6736)	(0.6420)	(0.7821)	(0.7000)
Long rains dummy	-0.7806	0.6588	-2.9216 **	3.8079 ***
	(0.5127)	(0.4776)	(0.8809)	(0.4828)
Short rains dummy	1.2977 ***	0.3821	-1.5204 **	3.4621 ***
	(0.4934)	(0.4563)	(0.7226)	(0.4866)
Age of oldest male	0.4786		-1.4986 ***	
	(0.2684)		(0.5068)	
Age of oldest male^2 x 10^{-2}	-0.5360 *		3.4693 *	
	(0.1350)		(2.0387)	
Age of oldest female		0.4879 ***		0.7711 ***
		(0.1702)		(0.1726)
Age of oldest female^2 x 10^{-2}		0.4109 ***		-2.8905 **
		(0.1580)		(2.3217)
Random effect scaling parameter	3.1967 ***	-2.8810 ***	-2.1513 ***	0.9366 ***
	(0.4689)	(0.6256)	(0.4164)	(0.2053)
σ	4.8892 ***		7.4645 ***	2.2284 ***
	(0.1737)		(0.2451)	(0.2398)
σ_{12}	-7.9646 ***		-3.4271	
	(1.3235)		(2.3616)	
Herd size joint sig. $\chi^2_{(2)}$	1.7	0.6	4.6 *	6.6 **
Age joint sig. $\chi^2_{(2)}$	26.6 ***	8.4 **	8.9 *	20.2 ***
Number of observations	687		980	

* indicates significance at the .10 level, ** at the .05 level, *** at the .01 level.

Table 3. Fixed Effects Estimation of Milk Production Function

	Chalbi	Dukana
Herd Size in TLU	0.0767 ***	0.1653 ***
	(0.0137)	(0.0403)
Herd Size in TLU^2 (x 10^{-2})	-0.0052	0.0549
	(0.0044)	(0.0820)
Distance in hours from town	0.0102	-0.0462
	(0.0440)	(0.0289)
Distance in hours from town^2	-0.0001	0.0016 *
	(0.0013)	(0.0008)
Percent of herd at satellite camp	0.2092	-0.1102
	(0.7295)	(0.3081)
Rainfall in past six months	0.0169 ***	0.0042
	(0.0059)	(0.0036)
Rainfall in past six months^2 (x 10^{-2})	-0.0059	0.0010
	(0.0036)	(0.0019)
Long rains dummy	1.3419 ***	2.3547 ***
	(0.2272)	(0.1412)
Short rains dummy	0.5048 **	1.3754 ***
	(0.2024)	(0.1309)
Time trend[1]	0.2366 ***	0.1603 ***
	(0.0893)	(0.0503)
Period^2	-0.0149 ***	-0.0086 ***
	(0.0045)	(0.0025)
Constant	-1.6380 ***	-1.6233 ***
	(0.3907)	(0.2540)
Herd significance $\chi^2_{(2)}$	176.0 ***	103.5 ***
Distance significance $\chi^2_{(2)}$	4.3	0.1
R^2	.38	.28
Number of observations	687	980

* indicates significance at the .10 level, ** at the .05 level, *** at the .01 level

[1] 1993 long rains =1, … 1997 2nd dry season =20

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Notes

[1] In this paper, we do not try to distinguish among different types of cooperative outcomes, such as the joint cooperative solution and the individual solution. Much of the intrahousehold literature has focused on determining which cooperative outcome results, based on bargaining power or other factors. We will just model the joint cooperative solution, and note that the individual solution is a special case of it.

[2] A unitary model assumes that the household acts as though there is one decision-maker. Bargaining models explicity note that there may be more than one decision-maker and that the decision makers may have different preferences.

[3] Two different themes in the literature on milk marketing merit note. First, it is frequently found that milk marketing is a function of wealth as represented by herd size (Nduma *et al.* 2001; Herren, 1992; Holden *et al.* 1991) and that milk marketing is a function of household distance to market (Holden and Coppock, 1992). Our focus in this study also builds on the latter theme.

[4] On average, 12% of home produced milk is sold.

[5] On average, 19% of this income measure is cash income. The remainder is derived by assigning market values to home produced and consumed goods.

[6] The definition of this sample did not include former herders who have moved to the small towns of the study area, either in search of economic opportunities or due to the loss of their

herd. Issues of selection bias are possible if herders who lost their animals between 1992 and 1997 were systematically overlooked due to the sampling method based on the outcome of herders still residing in the grazing areas. However, discussion with both nomads and town residents indicated this was not likely to be a major issue, as there was not a significant population flow from the rangelands into the towns during this time period, and very few households were forced out of pastoralism due to the herd losses experienced in 1996.

[7] Respondents appeared to have little difficulty in recalling season-specific information over the four year time period covered in this study. This was likely aided by the fact that widespread herd losses in 1992 served as a notable starting period. In addition, herd genealogies were constructed for camels and cattle to record livestock production information, and served as the foundation for other questions (for a discussion of this methodology, see Turner, 2003). In a society where records are not written, information contained in herders' memories serves a critical function in herd management decisions. Knowledge of complicated genealogy structures and historical events is critical for both Gabra society and for herd management decisions (Tablino, 1999; Robinson, 1985; Torry, 1973). While repeated observations would be preferable for construction of a longitudinal data set, the recall data in this study is internally consistent, and is in our judgment reliable enough to analyze empirically.

[8] The data set is not longitudinal in the sense that there are repeated observations of a single household over time by an interviewer gathered during multiple visits, but it is longitudinal in the sense that the interviewer recorded repeated observations made by the household over time, but did so during a single interview.

[9] This is the milk produced for human consumption. Traditionally, half the udder of a milking animal is taken for human consumption and the other half is left for young stock to suckle.

[10] The adult equivalent weighting scheme used in this study assigns a value of one to individuals of both sexes older than 15, a value of .6 to individuals 6-14 years old, a value of .3 to children ages 2-5, a value of .1 for children under 2.

[11] One livestock unit = 10 sheep or goats = 1 head of cattle = 0.7 camels. This differs slightly from the scheme in Schwartz et al. as they weigh 11 goats equal to one TLU. As the total number of sheep and goats is the variable recorded in the data set, the composite measure of smallstock is assigned a weight of 1 animal = 0.1 TLU.

[12] The rainfall and food aid records were provided by the Catholic mission in North Horr and the AIC mission in Kalacha.

[13] While the focus of this paper is the dynamic process of cultural adaptation to market development, we develop our argument through models of different states of this process as separate static models rather than through use of a unified dynamic model. This keeps the model as simple as possible while illuminating our main points. We leave as a future extension the connection of these different phases in a unified dynamic model.

[14] Within the cooperative models, the outcomes would differ depending on the weights assigned to each person's utility. But changing the weights would not affect the sign on the distance variable, which is our concern in this paper.

[15] This allows us to focus attention on the static aspect of the distance and milk sales decision. Livestock sales introduce a dynamic element to the model that we chose to ignore at this stage in the interest of simplicity.

[16] The price of milk was constant over the study period at a price of 20 shillings per liter.

[17] In our field work, we heard wives advance the story that milk sales will enhance household welfare overall, as they provide food and clothing for themselves and the children with this income, leaving the husband to consume the milk-based diet that he expects. In this case, we could assume the children's welfare is subsumed under the wife's utility. Milk sales in this case expand the household's budget constraint due to the advantageous caloric terms of trade that characterizes milk-grain terms of trade in this area. This increases overall household welfare, while not detracting from the husband's utility. However, we also had husbands propose that when women gain control over income they will adversely impact the household budget as they will spend the proceeds of milk sales on town based boyfriends or other non-household expenses thus depriving the household of both milk and income from milk sales. In this case, we could assume the children's welfare is subsumed under the husband's utility. Fratkin (2003) quotes a woman from the neighboring Ariaal group reflecting on issues of women's control over income saying "…some men oppose their wives to work for money, maybe they think we will overlook

them and become proud, or we might leave them and go away with another man. With some people, this will happen." (p. 128)

[18] We model the disutility of milk sales arising in the reduced milk available for the husband's consumption. The disutility of knowing the wife has control over income is not explicitly modeled, but from the comments reported in the previous footnote, could certainly be relevant.

[19] The relative age of men and women is often considered a measure of bargaining power. For example, Lundberg, *et al*, 2003, Laferrere 2001, and Lundberg and Ward-Batts, 2000.

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[20] Note that although most of the households sold milk during at least one of the periods of the survey, most of these households also had periods where they sold no milk. Only one of the 88 households surveyed sold milk in each period recorded.

[21] We can reject the hypothesis that herd splitting has a direct impact on milk production, as seen in table two. We also conducted bootstrap estimation of a three variable endogenous system (distance from town, use of satellite camp, and milk sales level). The results from this estimation lead us to accept the traditional model, as milk sales does not significantly impact distance from town for either Chalbi or Dukana.